Title- **Changing productivity and exports in the Australian meat processing industries**

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Introduction

The Australian meat processing industry is a major contributor to global food trade, accounting for around 4 to 6 per cent of total global trade in meat products. During the 1990s, these industries exported A$4 to A$6 billion of meat products and A$0.6 to 0.9 billion live animal exports or close to 18 per cent of total Australian agricultural exports.

The long term sustainability of the Australian meat processing industries depends significantly on maintaining its competitiveness by achieving cost advantages through innovations in production technologies and entrepreneurial skills. Such innovations tend to be related to rising productivity.

The objective of this paper is to explain empirically the role of changes in productivity in sustaining the export growth of the Australian meat processing industries. Specifically, it aims to quantitatively analyse the effects of productivity changes, as measured by the total factor productivity (TFP), on the share of meat in total Australian agricultural exports for the period 1980 to 2002.

Overview of the meat processing market

With globalisation meat processing is becoming extremely competitive leading to domination by large multinational processors with highly developed global brands. In these circumstances the Australian meat processing industry will need to continually achieve improved productivity to sustain its position as a strong player in the global market.

An analysis of the market dependency by product reveals that the Australian beef and sheep industries are export focused while the poultry and pig industries are largely dependent on the domestic market (table 1).

Table 1: Australian meat market shares

Markets	Beef/veal	Mutton	Lamb	Pig	Poultry
Domestic	35	33	26	84	96
Export	65	67	74	16	4

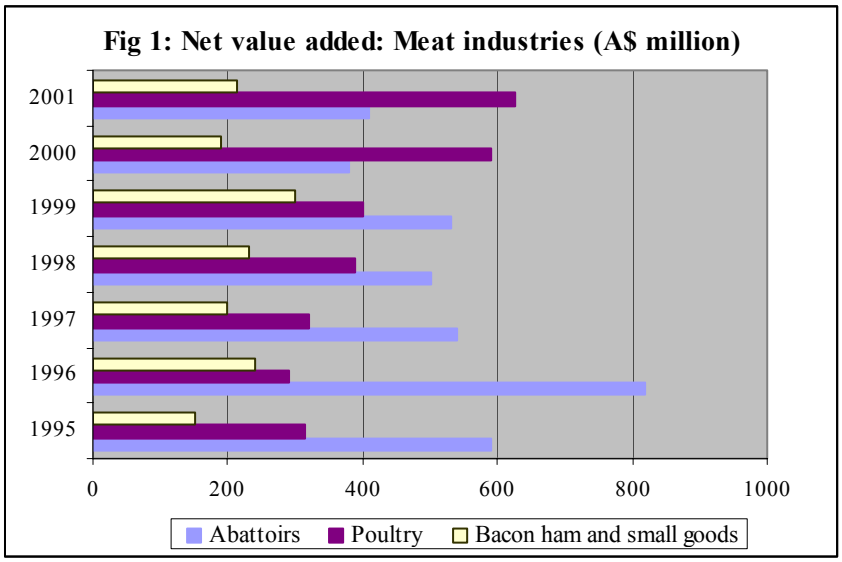
Source: ABARE (2002)

Meat processing firms are widely distributed throughout Australia. Meat processing firms are concentrated in the grain-livestock belt of Victoria, Queensland and New South Wales (Smith and Jahan 2003). Other major processing centres in Australia include Gippsland in Victoria, along the Murray River, the southern tablelands of New South Wales, around Brisbane and south of Perth. Northern Australia has a smaller base of food processing than the rest of Australia. The reasons for this smaller

base have been primarily associated with transport logistics, insufficient volumes of inputs to sustain a substantial operation and raw materials costs. However, some of these constraints are easing and some competitive advantages have been also emerging recently.

In terms of sales and employment the abattoir sector is the largest component of the meat processing industry (comprising meat abattoirs, poultry processing and bacon, ham and smallgoods manufacture). However, over recent years the net value added of the abattoir sector has been low in relation to sales turnover. For example, in 2000-2001 the net value added by abattoirs was around 4.9 per cent of sales turnover. By comparison, the net value added of the poultry processing sector has been much higher in relation to sales, achieving a net value added of around 24 per cent of sales. While there are differences in the nature and organisation of the two industries, recent trends in industry net value added for the meat and poultry industries form a stark contrast (figure 1).

Fig 1: Net value added: Meat industries (A$ million)



Between 1994-95 and 2000-2001 the net value added of abattoirs declined by 36 per cent in constant dollar terms. Over that period total sales revenue fell by 2.1 per cent in constant dollar terms despite stronger export sales in the last two years. Increased total labour costs – up 27 per cent in constant dollar terms - were a major factor contributing to the fall in net value added. The number of establishments fell by 18 per cent. The relationship between the value of purchases and sales declined slightly from 75 per cent in 1994-95 to 73 per cent in 1999-2000, suggesting a slight increase in processing margins over the period.

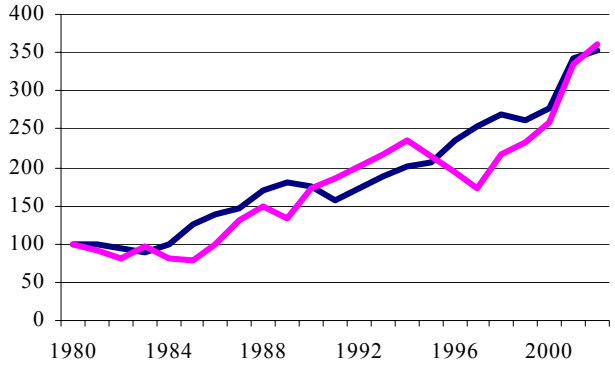
By contrast, the net value added by poultry processing firms increased over the same period with much of this occurring between 1998-99 and 1999-2000. A reduction in costs was the main reason for this increase. While total sales declined by more than 2.0 per cent between 1994-95 and 2000-2001, total costs declined by nearly 15 per cent (ABS 2002), reflecting a fall in the value of purchased inputs – presumably associated with the cost of chicken purchases. Farm gate prices of chicken fell by 21 per cent over the same period (ABARE 2001).

Australian exports of processed meat

Australian meat processing industries are increasingly contributing to the growth of exports as well as to the domestic market. In 2002 Australia exported 1.2 million tonnes of meat including beef and veal, mutton, lamb, mutton, pig and other substantially processed meat products, valued at A$6.3 billion while the industry sold more than 1.3 million tonnes of those products, worth of A$10.8 billion, on the domestic market.

The total value of Australian agricultural exports rose from A$8.4 billion in 1980 to more than A$29.5 billion in 2002 - an annual increase of around 2.6 per cent. The value of processed meat exports increased from A$1.41 billion to A$6.32 billion over the same period. Total Australian meat product exports increased by only 2.7 per cent over the same period (figure 2). Growth in meat exports mainly occurred as a result of improved technology and comparatively lowers costs of transportation, communication and continued expansion of the global environment in trade (Gleeson et al. 2003).

Fig 2: Growth in agricultural and meat exports 1980-2002 (base=1980)



While total Australian agricultural and meat exports increased over this period, meat exports exhibited greater year to year variability. Processed meat exports declined much more than total agricultural crop commodities when the real value of the Australian dollar was comparatively higher or appreciated against the US dollar. This reflects that the processed meat and meat products were more susceptible to currency valuation rather than the bulk commodities.

Productivity in the Australian meat industry

Productivity growth in Australian livestock industries is an important aspect of farm financial performance, and reflects the gains derived from adopting new technologies and better farming methods (Knopke et al. 2000). Finding further productivity gains will be a key factor in determining future changes in agricultural industries and will also be important for maintaining international competitiveness.

Rodriguez et al. (2003) based on Australian Bureau of Agricultural and Resource Economics (ABARE) farm survey data estimated total factor productivity growth rates for the livestock sector. Estimated growth rates were highest for mixed livestock-cropping industries (sheep-crops, beef-crops and crops-sheep-beef), where annual growth rates of 2.3 to 2.5 per cent were achieved. The estimated productivity growth rates were lower for other industries — beef specialists (1.8 per cent), sheep specialists (0.9 per cent) and sheep-beef enterprises (1 per cent). Examining the productivity growth of beef specialists on a regional basis, it was found that northern beef specialist achieved a higher productivity growth rate than southern beef specialists (2.2 per cent per year compared to 1.3 per cent per year). While further analysis is required to identify the causes of these differences, it is likely that improved herd management in the northern Australia are likely to be important factor contributing to higher productivity growth in the north.

In an exploratory analysis of total factor productivity growth rates in different sized farms it was found that large beef specialist farms had a higher productivity growth rate than smaller beef specialists. One of the possible reasons for the higher productivity growth of larger farms is their better financial resource base, providing these producers with an advantage in absorbing the cost of capital.

Growth in output in the Australian meat processing industries from 1980 to 1998 was low at 0.37 per cent per year. Growth in input use contributed positively but growth in total factor productivity was negative. This resulted in a real cost increase of $4 million (Jahan et al. 2003) in the meat processing industries.

Export and Productivity Nexus

Australia has a relatively small and slowly growing domestic meat market. If the Australian meat industry is to grow it needs to increase its exports. One motivation to expand processed meat exports has been and continues to be the stimulation of farm output and employment. Estimating the effects that processed meat exports have on the growth in farm output growth and employment requires an economy-wide approach. However, it is believed that high productivity growth rate has a very significant impact on the share of exports. Several studies have empirically shown that trade and growth are positively related (Gopinath and Carver 2002, Proudman and Redding 1998, Sachs and Warner 1995, Ben-David 1993,). The main findings of these studies reveal that productivity growth that is generated from reallocation of resources generally increases the share of export.

The productive firms due to their economies in scale, are believed to be capable of undertaking the risk of paying observed and unobserved costs and thus enabled them to enter into trading. It shows a causal relationship that flows from productivity to exporting and this relationship have been developed in the works of Roberts and Tybout (1997), Duranton (1998) and Bernard et al. (2000). The usual expectation is that due to reductions in trade barriers, only competitive firms will survive and least productive plants will leave the industry. This expectation increases the possibility of raising aggregate productivity and therefore exposes the firms towards more trading.

Research undertaken by Coyle et al. (1998), Bernard et al (2001) and Gopinath and Carver (2002) found that productivity, inter sectoral linkages and capital growth have a significant influence on export share. Bernard et al. showed that export oriented

industry grew faster in terms of both domestic and foreign sales. Exporting is associated with the reallocation of inputs, both labour and capital, from less efficient to more efficient firms. He also recognised the possibility that faster productivity growth allows firms, industries and the economy to increase the flow of exports. Gopinath and Carver (2002) showed that productivity gains in the primary agricultural sector ultimately flow to the downstream food processing sector.

Empirical framework

Dixit and Norman (1980), Woodland (1982), Harrigan (1997) and Trefler (1993, 1995) contributed significantly in developing an approach to test and identify the effects of technological change on the pattern of agricultural trade. The approach used in this paper draws heavily on the conceptual contribution and empirical application of those studies mentioned and especially the method used by Gopinath and Carver (2002) to examine the effects of technology and factor supplies on specialization within agriculture.

The approach is based on gross domestic product (GDP) function and extended to a gross national product (GNP) function (following Diewert and Morrison 1986). The GNP (revenue) function then can be shown as a sum of sectoral GNP (revenue) functions, such as agricultural, food processing, manufacturing, and others and their sum equals to GNP of the country. The sectoral GNP functions incorporate technological change.

The empirical model followed the translog functional form and each of the price and good vectors is reduced to a scalar. Domestic, exports and import goods are aggregated into a single good. For each sector a translog GNP function {G (P, V, ω)} including exports and imports is considered in the specified model. G (P, V) is the revenue or GDP function, *P* is the vector of final goods prices and *V* represents factor endowments. ω denotes the level of technology and empirically represents productivity levels. The approach then, differentiating ln G (P, V, ω) with respect to the export price ln (P_{xt}) estimated the export share in GNP. The export share of meat (can also called as price expression) has been estimated as:

Export Share = S_{Xt}

$$P_{xt}y_{xt}/(p_{dt}y_{dt} + p_{xt}\ y_{xt} + p_{mt}y_{mt} + p_{it}y_{it}) \equiv s_{Xt} = \delta_X + \sum_{n=D,X,M}\delta_{nX}.\ln(P_{nt}) +$$

$$\sum_{i=R,L,K}\phi_{ix}.\ln(V_{it}).+\mu_x \ln(\omega_t^{mp}).....(1)$$

Where $p_d, p_x, p_{m,} p_i$ are price vectors and y_d, y_x, y_m, y_i are good (quantity) vectors, while index *n* = D, X, and M denote outputs, exports and imports, index *i* = R, L, and K denote land, labour and capital stock (factor endowments) respectively, index *t* indicates time.

To focus the effects of factor endowments, technologies and other exogenous variables, following Gopinath and Carver (2002) the price expression in equation 1 can be reduced as follows:

$$S_{xt} = \delta_x + \alpha_x + \beta_x S_{xt-1} + \sum_{i=l,k} \phi_{iX} \ln(V_{li} / V_{Rt}) + \mu_x \ln(\omega_t^{mp}) + \pi_x \ln(E_t) + \upsilon_{ix} \ln(\omega_t^A) + \varepsilon_t \text{.....(2)}$$

Where $\alpha_x = \sum_{n=d,x} \delta_{nx} \ln(p_{nt} / p_{mt})$

and

S_{xt} =Export share for meat

V_{kt} = index value for capital used in meat processing

V_{lt} = index value for labour used in meat processing

ω_t^{mp} = productivity in meat processing

ω_t^A = productivity in primary livestock sector

E= exchange rate

ε_t = error terms

Lagged dependent variable is used to acknowledges that reallocation of factors among sectors occurs with a lag in response to changes in technology and factor endowments (Harrigan 1997). In our current equation α is regarded as equal to 0, it has been assumed that the short and long run effects of factor endowments and productivity will have a similar impact on meat export shares. The normalization of factor endowments (the summation term in equation 2) imposes the condition that the meat export share equation is homogeneous of degree zero in the factor endowments of labour and capital.

$$\sum_{i=l,k} \phi_{j,x} = 0$$

P_i in the price equation denotes the price of domestic agricultural intermediates employed in the food processing sector, Y_m and Y_i are negative by definition (because in processed meat sector, imported intermediate inputs are different from domestic agricultural inputs and non agricultural intermediate inputs are also not considered here). The price of primary livestock commodities (P_i) is specified as P_i (ω^A), reflecting the fact that agricultural technological change (ω^A) leading to supply shifts causes primary livestock prices to fall, and thus benefits food processing. E is the real exchange rate in respect to the US dollar.

Data and estimated results

Data are mainly obtained from the Australian Bureau of Statistics (ABS), the Australian Bureau of Agricultural and Resources Economics (ABARE), International Financial Statistics (various issues) UNCTAD's websites, earlier works of Knopke et al. (1998 and 2000,) and Jahan et al. (2003). Meat processing industries total factor productivity and primary agricultural sectors productivity numbers are taken from Jahan et al. (2003), Knopke et al. (1998, 2000) and ABARE's internal estimation. Total agricultural domestic data are obtained from ABS while exports and imports of processed meat are collected from ABS trade data (following ANZSIC 211.0 classification) and AFFA's publication, Australian Food Statistics (various issues).

The analysis used gross capital stock expressed in Australian dollar as the capital stock while the employment statistics are taken from the census undertaken in different years and the ABS publication on manufacturing employment numbers and wages. The real exchange rate is taken from the International Financial Statistics published by the International Monetary Fund.

Estimation results

Variables used in the equation are estimated and their descriptive statistics are presented in Table 2.

Table 2: Time trend for some selected variables used in TFP

Variables	Mean	Median	Standard deviation
Export shares	0.22	0.21	0.02
TFP(meat proc)	2.51	2.46	0.28
TFP (agri products)	1.36	1.13	0.11
Labour*	48	47	32
Capital**	167	159	70

Notes: *labor in '000 numbers of full time and part time employees.
**capital is gross fixed capital stock

While estimating the export share equation, some issues arose. For example, the use of a one year lag produced an inconsistent estimate of the parameters. This issue was addressed by using a two year lag. The regression results for the export shares equation of the meat-processing sector are presented in table 3.

It has been found that five out of six coefficients are significant at the 2.5 to 10 per

Table 3: Long run effect of factor endowments and technology on export shares

Variables	Estimated coefficients	Standard errors
Intercept	-0.014	0.298
Lagged share of exports	0.483**	0.197
Labour	-0.2038**	0.086
Capital	0.027	0.049
TFP(meat)	0.058*	0.035
TFP(agri)	0.274**	0.112
Exchange rate	-.020*	0.086
R-squared 0.82		
F Statistics 8.00	Durbin Watson Stat= 2.19	

Notes: double asterisk (**) denotes statistical significance of 2.5 per cent while single asterisk(*) denotes a significance level of 10 per cent.

cent level. The lagged shares variable is very significant and the estimated coefficient (0.483) indicates that the lagged shares significantly influence the current export shares. The coefficient also reveals that the rate of adjustment is relatively fast. The effect of capital is positive but not significant, while the parameter estimates for labour is negative and significant. The positive role of capital shows that as capital accumulates in the food sector, the country is more likely to export meat products, however the insignificant effects of capital on export shares may be explained as such that it could have an impact on export production but not on the share of exports. The negative effects of labour implies that as the meat industry have increasing its export shares, the industry is getting less labour intensive relative to capital (the impacts of factor endowments on export share are relative due to the condition of homogeneity in the equation).

Depreciation (appreciation) of real exchange rate as presented here as the index of real exchange rate –0.02 in table 3 has positive (negative) impacts on the share of exports. This result has some conformity with other studies undertaken by Chambers and Just (1981), Duranton (1998) and Gopinath and Carver (2002). This finding has serious policy implication as the increase in export shares can influence and change the distribution of income to those people engaged with meat processing industries. An excess of exports over imports, a positive trade balance, as a proportion of domestic demand would have a favourable impact on employment. By promoting exports employment can be sustained and increase in the sector.

The effect of primary livestock productivity is positive and significant. The impact of meat processing TFP is also positive and significant. These coefficients are significant at the 2.5 per cent and 10 per cent level respectively. The impact of primary livestock productivity (0.274) is more intensive than compared to meat processing's productivity (0.058). The result reveals that productivity in the primary livestock sector results in the meat exports shares increasing. One explanation of this impact is the supply effect. Higher productivity in the primary livestock sector leads to lower prices for agricultural inputs (livestock) to the meat processing sector. Lower input prices facilitate the meat processing sector to operate more efficiently in export market and help to expand export shares. Again, the meat processing industry is more intensive in its use of labour (-0.2037) than capital (0.02658). The result indicates that the Australian meat processing industries are more labour intensive than capital, consistent with low rates of capital inflow to the industry

Jahan et al. (2003) while analysing the partial productivity of labour and capital for the processed meat industry for different sub periods between 1980 to 1998, found that labour productivity in 1987 to 1992 increased by 2 per cent accompanied by a strong growth of 6.6 per cent in capital productivity. Labour productivity, over the periods was much lower, averaging 0.9 per cent a year, ranging from 0.8 per cent to 2.0 per cent a year in the three sub periods (1980-86, 1987-92 and 1993- 1998). Although capital productivity grew from 0.7 per cent to 6.6 per cent a year, over the first two sub periods, the capital labour ratio was declining during the second sub periods, consistent with low rates of capital inflow to the industry (Zsirossy 1996, p.2).

The results have significant policy implications. Usually due to higher labour costs, the industries in developed countries are more capital intensive. However, the meat processing industry because of its nature of operation (such as, slaughter, skin,

eviscerate and cut each carcass into large pieces, clean and salt hides, make sausage) is more labour oriented. Job growth in the meat industry, because of its nature of work (like sorting, cutting and chopping tasks are difficult to automate) is expected to rise along with the growing demand for food products. However consolidation of meat processing firms into larger ones with an increase in capital inflow could help the industry to realize cost savings. Low skilled labour (working in boning, slaughter, skinning and cutting) can become complementary to the technology used on the processing lines as the size of the processing firms and capital inflow increase.

Opportunities and challenges

The meat industry has a significant impact on the rural economy. Like many industries the meat processing industry appears to be consolidating into larger operations. Substantial economies of scale both in production and in processing are expected to continue to be the key driving forces. Supply chains usually bring different stages of production and processing under closer management with the aim of producing a final product closely suited to consumer requirements either in export or domestic markets.

The Australian poultry industry is already concentrated geographically and has started enjoying the benefits of vertical coordination. Employment in the poultry processing industry decreased from 9563 in 1996 to 8814 in 2001 while the value of production and turnover has been increased from A$ 948 million and A$ 2143 million to A$ 1156 million and A$2903 million, an increase of 25 per cent and 36 per cent respectively over the same period. While the level of employment for meat manufacturing (excluding poultry) declined to 5469 in 2001 from 6139 in 1996 (Smith and Jahan 2003) the total value of production increased from A$ 4855 million to A$ 5388 (increased by only 10 per cent) over the same period.

Compared to the poultry industry the meat processing sector needs a more consolidated approach to raise its rate of growth in profitability and productivity. Especially the beef and lamb industries require a vertically coordinated management system, like poultry industry to bring livestock production and meat processing closer together and to influence the export shares. This observation has already been identified in the work of recent productivity estimates of Rodriguez et al. (2003).

Meat export markets are more important sources of demand than domestic markets in Australia. Production and productivity are the key driving forces for the rising share of exports. The global reach of the Australian meat industry now raises some concerns about the level of productivity in both the primary agriculture and the meat processing sector.

It has been found that rural employment has declined in the Australian meat industry (ABS 20001). Declining employment or rising production costs are now influencing the meat processing industries to regionally shift their plants and merge with some other plants. However, industry rationalisation could only save the productivity of the industry if the industry can play a very active role in raising skill levels of a stable work force.

The Australian meat industry is the single largest segment of the food manufacturing industry providing the largest share of global trade to Australia. Meat processing

appeared as a steady economic mechanism and more immune to business cycles (exports) than may other types of food processing sectors (AFFA 2003). But the industry has been confronted with some associated challenges. As the industry heavily relies on the export shares of production, the next questions then arise how to increase the level of productivity. Most challenging job is now to raise productivity, and one of the options available to the industry is to embrace new geographical concentration and vertical coordination in its production system.

Conclusion

The export market is the major outlet for Australian meat and meat products. Future growth of Australian share of meat in global trade will depend importantly on sustaining and improving the growth of productivity in the Australian processed meat sector. While the Australian meat export sector is growing, its share of global meat exports is almost constant. Productivity in the Australian primary livestock and meat industries is found to be very important determinant in explaining export shares of meat and meat products. However, more research is needed to know about the determinants and the factors responsible for growth in productivity.

Economies of scale and size are evident in the poultry but to a lesser extent in the beef industry also. Such developments are expected to enhance the processed meat sectors access to an assured supply. Closer integration between the livestock producers and the processing sector would enhance the meat industries capability to efficiently use its factor endowments. Consequently, further research is needed to evaluate the integration between the primary livestock and processing meat sectors to optimise the allocation of resources.

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